

Rhythm and Feet in Belhare morphology

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Abstract

In Belhare (Sino-Tibetan, Nepal), consonant prothesis at morpheme boundaries and deletion of stem ‘augments’ is found if either metrical or morphological parsing would violate the bimoraic trochee pattern that underlies the stress system of the language. This finding corroborates Dresher & Lahiri’s (1991) “Principle of Metrical Coherence” and provides new evidence for the cross-linguistic applicability of Crowhurst’s (1994) “Tautomorphemic Foot” constraint. The data also support a view of the Prosodic Hierarchy as weakly layered, allowing consonants to be directly dominated by the foot or word node if they are prothetic and do not therefore need feature licensing within the syllable canon.

1. A puzzle

The morphology of Belhare, an Eastern Kiranti (Sino-Tibetan) language spoken in Nepal, exhibits two intriguing types of phonological alternation. First, suffixation of a vowel-initial morpheme triggers gemination in some environments, but not in all:¹

- | | | | | | |
|-----|----|------------------------------------|---|------------|-------------------------|
| (1) | a. | N-ten-att-u-n
NEG-hit-PT-3U-NEG | → | ntennattun | ‘s/he didn’t hit it’ |
| | b. | ten-uk-ma
hit-bring.down-INF | → | tennukma | ‘to hit and bring down’ |
| | c. | ten-u-ŋ
hit-3U-1sA | → | tenuŋ | ‘I may hit it’ |

Second, as in other Kiranti languages (Michailovsky 1985, van Driem 1987: 245 – 67, Ebert 1994: 19 – 21), most verb roots are suffixed by a *-t* or *-s* ‘augment’. These augments relate to notions of transitivity but are no longer productive nor semantically transparent. They are generally deleted before consonants (2a) and retained before vowels (2b). However, there are some environments where augments are deleted before vowels as well (2c):

- (2) a. lu-t-ma → luma ‘to tell’
tell-AUG-INF
b. lu-t-u → luru! ‘tell him’
tell-AUG-3U
c. N-lu-t-att-u-n → nluattun ‘s/he didn’t tell him/her’
NEG-tell-AUG-PT-3U-NEG

After consonant-final roots, augments are either retained (3a) or replaced by geminates (3b) before vowels:

- (3) a. leŋ-s-u → leŋsu ‘turn it!’
turn-AUG-3U
b. N-leŋ-s-att-u-n → nleŋŋattun ‘s/he didn’t turn it’
NEG-turn-AUG-PT-3U-NEG

The question is: what defines the environments in which gemination occurs as in (1) and in which augments are deleted before vowels as in (2) and (3)?

This paper suggests that both puzzles can be solved by close attention to the metrical structure of the morphological output. After providing background information about Belhare segmental phonology (Section 2) and syllable structure (Section 3) — especially about weight (3.1) and the nature of consonant prothesis (3.2) — I introduce in Section 4 the basic facts of Belhare metrical phonology, arguing that the language relies on moraic trochees but allows degenerate feet under word-level stress. Section 5 shows that, together with a constraint against heteromorphemic feet, the rhythmic stress pattern is responsible for gemination (5.1) and augment deletion (5.2). In Section 6, I compare the proposed analysis with other possible accounts and address historical-comparative questions. Section 7 closes the paper and offers some conclusions of theoretical interest. The Belhare material strongly supports the basic tenets of Prosodic Morphology (McCarthy & Prince 1993, 1995, etc.) and provides specific evidence for a model in which morphological constituents directly interact with the prosodic notions of stress rhythm and feet. The analysis is couched in an Optimality-Theoretic framework (Prince & Smolensky 1993; McCarthy & Prince 1993, 1995; Archangeli & Langendoen 1997, etc.) and rests exclusively on parallel, non-cyclic constraint evaluation.

2. Remarks on segmental phonology

Table 1 summarizes the taxonomic phoneme inventory of Belhare. Phonemes in brackets occur in loan-words only (mostly from Nepali and Maithili), but the breathy voiced stops [g^h], [d^h] and [b^h] also appear as regular allophones of aspirated voiceless stops between sonorants, for example, /taŋkhek/ : [ʔaŋg^hɛkʔ] ‘head’, /inthe/ : [ʔind^hɛ] ‘it laid an egg’, /daphek/ : [ʔdaɓ^hɛkʔ] ‘sickle’).²

k	kh	g	(gh)	ŋ	i	ĩ	ũ	u
t	th	d	(dh)	n		e	o	
c	ch	(j)	(jh)				(ʌ)	
p	ph	b	(bh)	m			a	
ʔ	h	l	r	s				

Table 1: Belhare phoneme chart (NB: <c> stands for [ts] and <j> for [dz])

The native phonemes in Table 1 are best broken down into the feature matrix in Table 2, which is justified by alternations that will be briefly discussed below and in Section 3. Since the [+spread glottis], [+voiced], and [+nasal] series are trivial variants of the plain stop series /k, t, p/, they are not included in the table. Following Clements & Hume (1995), I treat place specifications as unary features (marked by a dot), standing in equipollent opposition to one another.

	k	t	c	p	ʔ	h	r	s	l		i	e	a	o	u
dorsal	•									dorsal				•	•
coronal		•					•			coronal	•	•			
distributed			+					+		closed	+				+
labial				•											
lateral									+						
continuant						+	+	+							

Table 2: Distinctive feature analysis (without [±nas.], [±spread gl.] and [±voiced])

The single most important segmental alternation in Belhare concerns voicing in derived environments. For reasons of space, however, I limit myself here to a rough sketch of the facts, leaving a formal account to another treatise.

Single stops are generally voiced between sonorants if they are on either side of a (lexical or grammatical) suffix boundary. Coronals furthermore assimilate to [+continuant], resulting in /r/ (phonetically, a postalveolar flap or short trill):

- (4) a. ap-a → aba ‘Come over!’
 come.over-IMP
 b. khi-than-s-e → khidhanse ‘S/he quarreled with someone uphill.’
 quarrel-upwards-PT
 c. sat-u → saru ‘Take it out!’
 take.out-3U

A lexical exception is found with the non-past tense marker *-t*. This gives rise to minimal pairs like the following, where the augment *-t* voices, but not the otherwise identical tense marker:

- (5) a. pum-t-u → pumdu ‘take and squeeze a handful!’
 take&squeeze.a.handful-AUG-3U
 b. pum-t-u → pumtu ‘s/he will take and squeeze a handful’
 take&squeeze.a.handful-NPT-3U

Consonant clusters and geminates, too, are subject to an intersonorant voicing constraint, but this is systematically counteracted by a coda condition requiring codas to be unreleased and, as an accompanying phonetic tendency, to be voiceless. These two contradictory constraints bring about a ‘Half-Voicing Effect’ in geminates that derive from the same pattern as the one exhibited by the introductory puzzles:

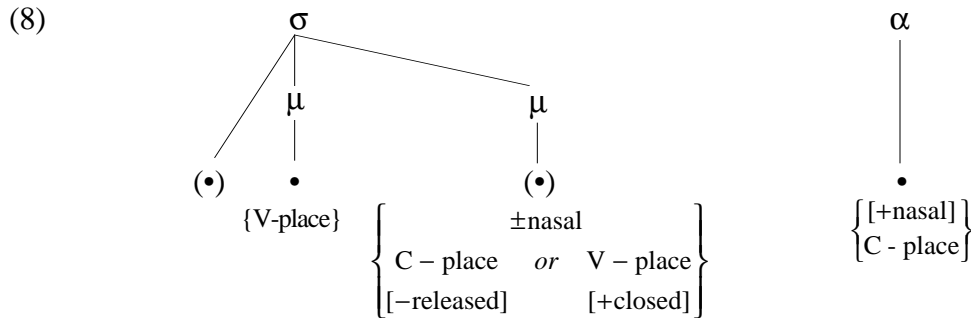
- (6) a. N-lap-att-u-n → [nˈlap̚ˌbat̚ˌtun] ~ [nˈlab̚ˌbat̚ˌtun]
 NEG-catch-PT-3U-NEG
 ‘s/he didn’t catch it’
 b. lap-hett-u → [ˈlap̚ˌbʰet̚ˌtu] ~ [ˈlab̚ˌbʰet̚ˌtu]
 NEG-catch-PT-3U-NEG
 ‘s/he is catching it’

The effect is blocked if geminates derive from underlyingly prespecified segments:

- (7) a. caleppa ‘bred’ → [ˈcaˌˌleppa], *not* *[ˈcaˌˌlepba]
 b. lap-pir-he ‘s/he caught it for her/him’ → [ˈlapˌˌpirhe], *not* *[ˈlapˌˌbirhe]
 catch-BENEF-PT

3. Syllable structure

The features in Table 2 are distributed over syllable positions following the scheme in (8), which adopts Goldsmith's (1991) theory of feature licensing, but assumes a moraic instead of a 'branching rime' approach to syllable constituency (Hyman 1985, Hayes 1989). Language-specific evidence for this choice will be provided below. The minor canon α is restricted to (unstressed) syllables prefixed to prosodic words (cf., e.g., *ntennattun* with [ŋ] as a syllabic nasal prefix in (1a) above). Root nodes are represented by bold face dots:



Without further specification (in curly brackets), syllable positions license all features available in Belhare, i.e., the features represented in Table 2 plus the [nasal], [spread glottis] and [voiced] features that were left out of the table. As indicated in (8), the coda position (i.e., the second mora position μ) can be filled by either a consonant or a vowel. Consonants are restricted to those with the primary place of articulation features [dorsal], [coronal], and [labial], i.e., {k, t, p} and {ŋ, n, m} — /s/ and /c/ are not allowed because their [+distributed] feature is not a direct daughter of the C-place in feature geometry (Clements & Hume 1995). Moreover, as we have seen in the preceding section, stops are uniformly unreleased and generally voiceless in the coda. Vowels in coda position must be [+closed], i.e., /i, ɨ/ or /u, ʊ/.

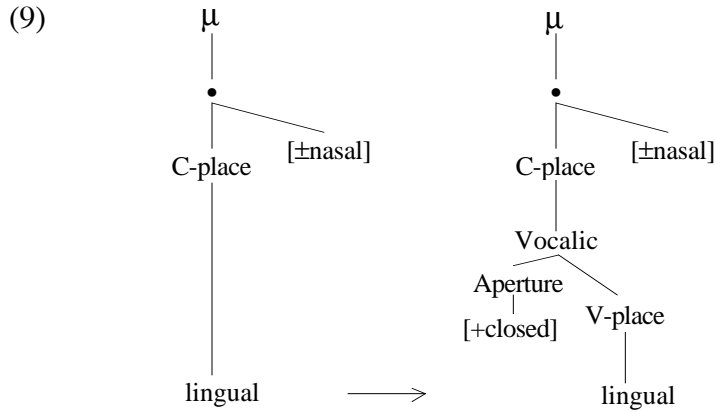
Two properties of the scheme in (8) are of particular importance for the analysis of the interaction between prosody and morphology in Belhare — the moraic equivalence of CVC and CVV syllables and the optionality of onsets. Let us take up these issues in turn.

3.1 The syllable rime and moraic structure

The syllable canon in (8) assumes a fundamental equivalence of CVC and CVV as bimoraic syllables, a finding that will be of crucial importance for the stress system to be discussed in Section 4. Immediate evidence for the CVC = CVV equivalence, however, comes from stem alternation in verbs, where the two skeleton patterns alternate systematically. Verbs

have a canonical CV(C) shape, but a series of inflectional endings require a stem form characterized by a diphthongal (CVV) template.

CVC roots are turned into diphthongs by inserting a Vocalic node in the feature tree, keeping all other features. The requirement of [+closed] vowels in the coda position (cf. (8)) selects /u/ and /i/ over /o/ and /e/ from among the dorsal and coronal vowels:



The rule in (9) is stated in terms of a 'lingual' node dominating [dorsal] and [coronal] (Clements & Hume 1995: 290, taking up a suggestion by Browman & Goldstein 1989) since roots ending in a labial consonant (*p*, *m*) do not undergo diphthongization. In the following examples, diphthong stems are selected by the non-past tense marker *-t* (followed by the intransitive first person plural (*-i*) or the transitive third person undergoer (*-u*) markers) and by the resultative perfect markers *-ŋe* (intransitive) and *-se* (transitive):

- (10) a. liŋ- 'put into' → liũ- (*liũ-t-u* 's/he will insert it', *liũ-se* 's/he has inserted it')
 b. luk- 'spill' → luu- (*luu-t-u* 's/he will spill it', *luu-se* 's/he has spilled it')
 c. im- 'sleep' → im- (*im-t-i* 'we'll sleep', *im-ŋe* 's/he has slept')
 d. lap- 'catch' → lap- (*lap-t-u* 's/he will catch it', *lap-se* 's/he has caught it')
 e. tan- 'jump' → taĩ- (*taĩ-t-i* 'we'll jump', *taĩ-ŋe* 's/he has jumped')

Missing from the paradigm in (10) are /CVt/ roots, which show exceptional behavior.³ Apart from the regular change from /t/ into /i/, a glottal constriction appears as well:

- (11) kat- 'come up' → kai?- (*kai?-t-i* 'we will come up', *kai?-ŋe* 's/he has come up')

This is the only environment where the Belhare syllable canon is expanded, and phonetically, the glottal closure is usually incomplete, resulting in laryngealization (creakiness) of the coda vowel. This suggests that, as in many other languages (Hyman 1977), the glottal

stop is not a regular weight-contributing, i.e., mora-dominated, coda constituent. It is better analyzed, following Michailovsky's (1986: 194) analysis of a neighboring language, as a '*trait vocalique*', or as a direct dependent of the syllable (σ) node. Under either analysis, ($_{\sigma}$ tai) 'come' and ($_{\sigma}$ tai?) 'bring' have the same bimoraic weight. This is a natural finding under the moraic feature licensing scheme in (8), but it is difficult to account for if weight were reduced to branching structure: under a purely geometrical approach, it is unclear how the glottal stop branch could be shown to be excluded from the rime constituent.

CV roots are fitted into the diphthong template by epenthesis of a [+closed] offglide in line with the syllable canon in (8). The default value of the epenthetic vowel is /i/ (12a-d), but after /i/, /u/ is chosen as the epenthetic vowel (12e), presumably as an effect of the Obligatory Contour Principle (on which see, among others, Goldsmith 1991: 309 – 318 and McCarthy 1986):

- (12) a. ta- → tai- 'come' (*tai-t-i* 'we will come', *tai-ŋe* 's/he has come')
 b. ŋe- → ŋei- 'count' (*ŋei-t-u* 's/he will count it', *ŋei-se* 's/he has counted it')
 c. so- → soi- 'wait' (*soi-t-i* 'we will wait', *soi-ŋe* 's/he has waited')
 d. tu- → tui- 'dig' (*tui-t-i* 'we will dig', *tui-ŋe* 's/he has dug')
 e. si- → siu- 'die' (*siu-t-i* 'we will die', *siu-ŋe* 's/he has died')

3.2 Onsets, weak layering and the nature of consonant prothesis

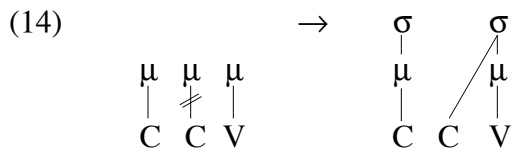
While onsets are normally optional in Belhare, they are required word-initially. This effects prothesis of a glottal stop (the default consonant according to Table 2) if vowel-initial melodies appear initially in the prosodic word (13a). Alternatively, high vowels may be syllabified as onsets, i.e., realized as glides (13b) (Prothesis and epenthesis are marked hereafter by outline font; dots represent syllable boundaries)

- (13) a. u-uk-ma → u.uk.ma 'to fry and bring down'
 fry-bring.down-INF
 b. iep-ma → yep.ma 'stand'
 stand-INF

From an Optimality-Theoretic perspective (at least of the 'classical' sort as formulated in Prince & Smolensky 1993 and McCarthy & Prince 1993), prothesis is triggered by the constraint ONSET dominating the anti-insertion constraint FILL(-C), which proscribes (consonantal) root nodes that are not filled with input material. Since Belhare limits onset

requirements to word-initial positions, however, some other constraint apparently bans prothesis word-medially. There are many ways to accommodate this situation, but the following approach suits best the over-all picture of Belhare that will emerge from later sections.

Following Itô & Mester (1992) and Spaelti (1994), I assume that the Prosodic Hierarchy is ‘weak’ and that its canonical layering is the by-product of constraint ranking rather than representational formalism. The only rigid formal properties of the hierarchy are, in Itô & Mester’s (1992) terms, the “Proper Bracketing” and “Proper Headedness” requirements that ensure, respectively, that higher constituent boundaries do not cut across lower constituents (e.g., feet do not split syllables) and that every constituent dominates a head at the next lower level. In addition, I assume as a general principle of constituent structure formalism, that adjunction is possible only at the margins of higher constituents. The level of adjunction, however, is flexible. Thus, onsets can adjoin to syllable nodes (σ) as in the feature licensing scheme in (8), but under certain conditions they can also adjoin to foot (ϕ) or word (ω) nodes. What is unconditionally required is only that they end up without a mora of their own, i.e., in a weightless position (Hyman 1985). The actual place of adjunction is governed by a language-specific ranking of *PARSE-Root* and *FILL-Root* constraints, where the root node can be consonantal or vocalic (cf. Spaelti 1994 on *PARSE*): *PARSE/FILL*-{C,V}-IN-{ μ , σ , ϕ , ω }. In languages like Belhare, which do not tolerate complex onsets or codas, a kind of moraic OCP simply bans adjacent consonants parsed by moras: *OCP- μ* >> *PARSE-C-IN- μ* . In order to have their features prosodically licensed according to (8) and to satisfy Itô & Mester’s (1992) Principle of Maximal Parsing (spelled out here as *PARSE-C-IN*-{ μ , σ , ϕ , ω }), the only escape for such OCP-victims is adjunction to a subsequent σ -node; otherwise, they would be stray-erased:



The logic behind this is essentially the same as the one underlying Hyman’s (1985) universal “Onset Creation Rule”, recast in a constraint-based framework.

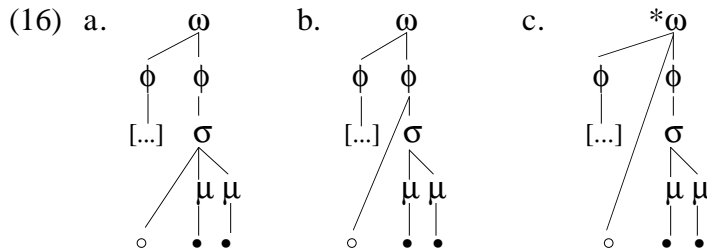
Prothetic consonants as in (13a), by contrast, do not need feature licensing by a syllable position since there are no underlying features. Therefore, they can also adjoin at higher levels than σ . Unlike underlying segments, however, prothetic elements are subject to *FILL* constraints and the parametrization of *FILL* as *FILL-C-IN*-{ μ , σ , ϕ , ω } determines the level of adjunction. Given that Belhare makes a difference between word-initial and word-medial

positions, we need to distinguish between FILL-C-IN- ω and FILL-C-IN- $\{\sigma, \phi\}$. The distribution of prothetic onsets then follows from ranking ONSET higher than FILL-C-IN- ω but lower than FILL-C-IN- $\{\sigma, \phi\}$:

(15) Prothesis word-initially vs. word-medially (*u-uk-* ‘fry and bring down’)

	FILL-C-IN- $\{\sigma, \phi\}$	ONSET	FILL-C-IN- ω
		**!	
		*	*
	*!	*	
	*!		*
	*!		

Note that, while (16a,b) are among the candidates in (15), representations like (16c) are excluded *a priori* because we assumed that center-adjunction is formally illicit:



In all these representations, I assumed feet to consist of two moras. The following section shows that this is empirically motivated.

4. Stress and foot structure

The Belhare stress pattern is acoustically not very prominent, except for two side-effects. One side-effect bears on unstressed syllables. In this environment, vowels are reduced in duration and slightly centralized in quality. Especially when followed by heavy syllables, unstressed vowels are often entirely syncopated in allegro speech:

- (17) a. 'phagi,det,lem 'butterfly' → ['phagi,det̚,lem] ~ ['phag,det̚,lem]
 b. 'wabhu,rūk 'cucumber' → ['wab̥u,rūk̚] ~ ['wab,r̥uk̚] ~ ['wab,rūk̚]
 c. 'singe,le?wa 'woodpecker' → ['singə,le?wa] ~ ['sing,le?wa]

A second segmental correlate of the stress pattern is that open syllables are optionally lengthened under main stress, especially in short words:

- (18) a. 'kiba 'tiger' → ['ki·ba] ~ ['kiba]
 b. 'khare 's/he went' → ['kha·rɛ] ~ ['kharɛ]

Notice that lengthening in (18) is a phonetic side-effect operative on the level of the prosodic word. There is no evidence that it plays any systematic phonological role in the language.

Like many other South Asian languages (cf. Hayes 1995), the Belhare stress pattern basically follows a trochaic rhythm of bimoraic feet (i.e., $\acute{\sigma}_L\sigma_L$ or $\acute{\sigma}_H$). Feet are constructed in a left-to-right parse. As expected, unfooted material is ignored by stress rules:

- (19) a. ('kasa)ma 'porcupine'
 b. ('phak)chi 'pigs'
 c. ('mak)kho(,rok)ma 'black' (often syncopated to ['makk̥h̥,ɾɔkma])

On the word level, the End Rule starts from left and stress assignment is iterative. Secondary stress is therefore placed on every non-initial foot:

- (20) a. ('noka)(,cik) 'brain'
 b. ('phek)(,kuli) 'buckwheat'
 c. ('sam)(,bhik) 'garlic'

Secondary stress on the peninitial syllables (20b) and (20c) shows that foot structure is quantity-sensitive (*pace* Bickel 1996a, b). If the trochees were quantity-insensitive, that is, bisyllabic instead of bimoraic, these syllables would not receive secondary stress but would be part of the initial foot. Additional evidence comes from longer words with a mixture of light and heavy syllables:

- (21) a. ('labho)ka(rik) 'a kind of small bird'
 not: *('la.bho)(ka.rik)
 b. ('rak)(khare)ŋa 'I got exhausted'
 not: *('rak.kha)(re.ŋa)

End Rule Left gives Belhare a quite different acoustic Gestalt from the neighboring Indo-Aryan language Nepali, although this language has the same foot structure and parsing direction, but with word-level stress assignment from the right (Bickel 1998). Another factor that makes up a sharp difference to Nepali is an additional rule of root-initial stress. This rule holds for all but a few lexically marked exceptions (e.g., *wa'reŋ* 'in the future', *itii'kha* 'small'; cf. below). In the example we looked at so far, the rule has no effect because the foot parsing predicts word-initial stress at any rate. However, if a root has a light initial followed by a heavy syllable, moraic foot construction would bypass the first syllable and main stress would fall on the second, heavy syllable ($\sigma_L\sigma_H$). The initial stress requirement overrides canonical foot construction in this case, giving rise to 'top-down' stressing of degenerate feet:

- (22) a. ('sa)(met) 'soul' → ['sa·met̃]
 b. ('ma)(nua) 'cat' → ['ma·nua]
 c. ('ca)(lep)pa 'bred' → ['ca·leppa]

Thus, Belhare appears to tolerate degenerate feet if — and only if — they bear main word stress. The language invokes, in other words, what Hayes (1995: 87) calls "a weak ban on degenerate feet". Independent evidence for this comes from the fact that Belhare has no "Minimal Word" constraint banning light syllables from constituting lexical words without phonological lengthening (mora epenthesis) — compare, for example, *mi* 'fire' or *wa* 'chicken'. Since Belhare feet are canonically moraic trochees, this can be accounted for only by loosening the ban on degenerate feet (cf. Hayes 1995: 90). To be sure, as is evident in (22), there is superficial phonetic lengthening in stressed degenerate feet, but this

effect is the same as stress-induced lengthening in canonical feet, as noted in (18) above. Neither my language consultants nor myself can detect any difference between main stress lengthening in degenerate (23a) and in canonical (23b) feet:

- (23) a. ('wa) 'chicken' → ['wa·]
 b. ('wachi) 'chicken (pl.)' → ['wa·ts^{hi}]

Interestingly, most lexical items with non-initial stress have a light-heavy syllable pattern in the beginning:⁴

- (24) a. wa('reŋ) 'in the future'
 b. i('tii)kha '(very) small'

Thus, the exceptional set is largely coherent in itself: words with exceptional stress simply observe a strong instead of a weak ban on degenerate feet.

5. Prosodic optimality and morpheme boundaries

A ban on degenerate feet means, in Optimality-Theoretic parlance, that the Foot Binarity constraint BIN- ϕ (or 'FTBIN') ranks higher than the constraint PARSE- σ requiring all syllables to be part of a foot. A weak ban means that BIN- ϕ is itself dominated by Hayes's (1995) Continuous Column Constraint (CONTCOL); in other words, BIN- ϕ can be sacrilegied in order to sustain a higher grid mark (25a), and only for that purpose (also cf. Eisner 1996). Such a higher grid mark is found on regular lexical roots since they require word-initial stress, that is, INITX or, equivalently but more cumbersome, ALIGN-LEFT (Head _{ω} , $\sqrt{}$). Irregular words differ in ranking BIN- ϕ higher than INITX (25b):⁵

- (25) a. Foot construction with initial stress requirement (*samet* 'soul')

	CONTCOL	INITX	BIN- ϕ	PARSE- σ
$\begin{array}{c} x \\ \text{☞} \quad (x)(x.) \\ \text{sa.met} \end{array}$			*	
$\begin{array}{c} x \\ (x.) \\ \text{sa.met} \end{array}$		*!		*
$\begin{array}{c} x \\ (x.) \\ \text{sa.met} \end{array}$	*!			*

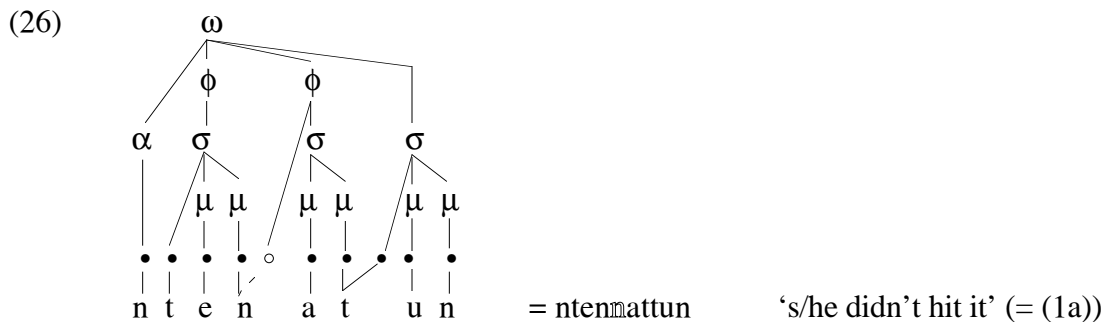
b. Exceptional foot construction without initial stress (*wareŋ* ‘in the future’)

	CONT COL	BIN- ϕ	INIT X	PARSE- σ
$\begin{array}{c} x \\ \text{☞} \quad (x \cdot) \\ \text{wa.reŋ} \end{array}$			*	*
$\begin{array}{c} x \\ (x) (x \cdot) \\ \text{wa.reŋ} \end{array}$		*!		
$\begin{array}{c} x \\ (x \cdot) \\ \text{wa.reŋ} \end{array}$	*!			*

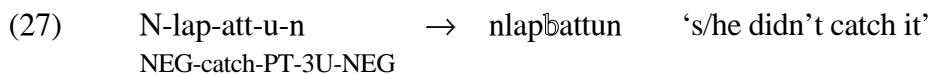
Together with a constraint against heteromorphemic feet (Crowhurst 1994), the logic of this constraint evaluation allows a straightforward analysis of the puzzle presented in the introduction. In the following, I first concentrate on gemination (Section 5.1) and then on augment deletion (Section 5.2).

5.1 Gemination as foot-driven consonant prothesis

As noted in the introductory section, morpheme-final consonants are geminated in some environments. With nasals, this can be analyzed as a simple case of onset insertion, i.e., prothesis. As with the cases of word-initial prothesis (cf. Section 3.2), this is best represented by an empty root node (‘ \circ ’) adjoined to a subsequent syllable or foot node (a choice that is immaterial for current purposes — but see below); place features spread from the left:



The same holds for oral consonants, but with the additional requirement that the prothetic consonant be voiced (cf. (6) in Section 2):



In both cases, the reason for root node prothesis is foot construction.⁶ Intuitively, the prothetic consonant introduces a new foot boundary so that the preceding foot (i) is bimoraic, allowing regular trochaic stress, and (ii) does not cross a morpheme boundary. This is made explicit in (26). Let us see how the analysis is motivated.

Metrical parsing of a CVC-VC morpheme sequence as in (26) and (27) yields a non-canonical foot structure, that is, either a trimoraic foot or a monomoraic foot followed by a bimoraic one. Underparsing syllables is of no help because it would not support the initial word stress found on these forms as on any other (canonical) Belhare words:⁷

- (28) * x x
 (x ..) (x)(x.) (x.)
 ten-att te.nat or te.nat or te.nat etc.
 hit-PT

Inserting an onset at the morpheme boundary is precisely the change needed to bring the output in line with the bimoraicity constraint BIN- ϕ :

- (29) x
 (x.)(x.)
 ten. nat


The following tableau shows how a low ranking of the anti-insertion constraint FILL-C correctly predicts (29) as the output of *ten-att* ‘hit-PT’:

- (30) Foot construction from CVC-VC (*ten-att* ‘hit-PT’)

	CONTCOL	INITX	BIN- ϕ	FILL-C	PARSE- σ
<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">☞</div> <div style="text-align: center;"> x (x.)(x.) ten.nat </div> </div>				*	
<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">☞</div> <div style="text-align: center;"> x (x)(x.) te.nat </div> </div>			*!		
<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">☞</div> <div style="text-align: center;"> x (x ..) te.nat </div> </div>			*!		
<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">☞</div> <div style="text-align: center;"> x (x.) te.nat </div> </div>		*!			*
<div style="display: flex; align-items: center;"> <div style="margin-right: 5px;">☞</div> <div style="text-align: center;"> x (x.) te.nat </div> </div>	*!				*

Suffixing heavy syllables like *-att* to vowel-final morphemes, for example to *yu-* ‘go down’, does not trigger prothesis, because BIN- ϕ would still be violated. This shifts the evaluation down to FILL-C, which objects to **yu(yat)*:

(31) Foot construction from CV-VC (*yu-att* ‘go.down-PT’)

	CONTCOL	INITX	BIN- ϕ	FILL-C	PARSE- σ
x (x)(x.) yu.yat			*	*!	
 x (x)(x.) yu.at			*		
x (x.) yu.at		*!			*
x (x.) yu.yat		*!		*	
x (x.) yu.at	*!				*

There are also morphemes which look even heavier than *-att*, but these invariably involve a closed vowel followed by VC. This allows satisfaction of BIN- ϕ by simply syllabifying /i/ as an onset, in parallel with the word-initial /iV/ and /uV/ melodies discussed in Section 3.2 (example (13b)). A consequence of this is that VVC-suffixes do not require prothesis. The following illustrates CVC-VVC syllabification with the non-past marker *-iuk*, an allomorph of *-t* (cf. (5b) in Section 2) in word-final position. Following the pattern described in Section 2, I assume stem-final /p/ to voice in onset but not in coda position:

(32) (x.)(x.) (x)(x..)
hap-iuk → hap.yuk, *not*: *ha.biuk ‘s/he cries’
cry-NPT

Note that the syllable **_(σ) biuk*, or **_(σ) byuk*, would also be in conflict with the Belhare syllable canon as set out in (8) (Section 3) — in other words, the forms would violate the syllable canon condition ‘COND- σ ’.

After open-syllable morphemes, the foot binarity constraint BIN- ϕ leads one to expect that the initial /i/ of *-iuk* ‘non-past’ (or *-iakt* ‘imperfective’) is parsed as a coda. However, this is not the case:

- (33) $(x)(x.) \quad (x.)(x.)$
 ta-iuk → ta.yuk, *not*: *tay. uk ‘s/he comes’
 come-NPT

Similarly, the ranking of BIN- ϕ above FILL-C suggests that the metrically ill-formed morpheme sequence *ta-ket* triggers prothesis as above. Again, this is not what we get:

- (34) $(x)(x.) \quad (x.)(x.)$
 ta-ket → ta.get, *not*: *tak.get ‘s/he is coming’
 come-INC

The reason for this apparent exception to BIN- ϕ is found in a pattern characteristic of the forms in (29) through (32): morpheme boundaries come to lie precisely at foot boundaries. In particular, prothesis in (30) optimizes the feet not only prosodically, but also morphologically, by ensuring that the morpheme boundary between *ten-* ‘hit’ and *-att* ‘PT’ does not cut across a foot: $*_{(\phi)}(\text{te-nat})$ or $*_{(\phi)}(\text{te})(\text{n-at})$. This finding is enshrined in a generalized version of Crowhurst’s (1994) “Tautomorphemic Foot” constraint. While Crowhurst’s Australian data suggest formulating the constraint as banning morpheme boundaries falling between the two syllables or moras of a foot, Belhare points to a constraint against morpheme boundaries anywhere in the foot:⁸

- (35) TAUTO- ϕ : $*_{(\phi)} \text{I}_M$

While BIN- ϕ and TAUTO- ϕ frequently work in tandem, this is not the case in the CV-VVC and CV-CVC sequences illustrated by (33) and (34). Here, fulfillment of the binarity requirements is overridden by the tautomorphemic foot constraint (assuming satisfaction of CONTCOL and INITX):

- (36) a. Foot construction from CV-VVC (*ta-iuk* ‘come-NPT’ as in (33))

	TAUTO- ϕ	BIN- ϕ	FILL-C	PARSE- σ
☞ $(x)(x.)$ ta-.iuk		*		
$(x.)(x.)$ ta-i.uk	*!			

- b. Foot construction from CV-CVC (*ta-ket* ‘come-INC’ as in (34))

	TAUTO- ϕ	BIN- ϕ	FILL-C	PARSE- σ
☞ $(x)(x.)$ ta-.get		*		
$(x.)(x.)$ ta-k.get	*!		*	


The tautomorphemic foot constraint has wide-reaching consequences in Belhare that we will explore in the following section, which will be devoted to augment deletion. Before moving on to that issue, however, another particularly important effect of TAUTO- ϕ to be noted is that it blocks foot construction and prothesis whenever monomoraic instead of bimoraic suffixes are involved. To see this, it is best to distinguish two cases: in the first case, the monomoraic suffix is followed by other material allowing projection of an additional foot; in the second case, no material follows. I address these two cases in turn.

The following illustrates a monomoraic suffix followed by a C-final suffix. From a purely prosodic point of view, this creates exactly the same CVCVC input that triggered prothesis in (30). However, there is no gemination effect:

- (37) a. $\text{ten-u-}\eta \rightarrow \text{ten}\eta$, *not* $^*\text{ten}\mu\eta$
 hit-3U-1sA
 ‘I may hit it’
 b. $\text{n-lu-ni-}\eta \rightarrow \text{nlun}\eta$, *not* $^*\text{nlun}\mu\eta$
 NEG-tell-NEG-1sA
 ‘I may not tell him/her’

The crucial difference between examples such as these and the prothesis-triggering pattern CVC-VC in (30) is that the additional morpheme boundary violates TAUTO- ϕ regardless of prothesis: $^*(\phi \text{ ten})(\phi \mu\text{u-}\eta)$ and $^*(\alpha \text{ n-})(\phi \text{ lu-n})(\phi \text{ mi-}\eta)$ violate TAUTO- ϕ as much as $^*(\phi \text{ te})(\phi \text{ n-u-}\eta)$ and $^*(\alpha \text{ n-})(\phi \text{ lu})(\phi \text{ ni-}\eta)$. Under these circumstances, the only way to rescue the input is by underparsing all but the first syllable, that is, by leaving all other material unfooted: $(\phi \text{ te})\text{n-u-}\eta$ and $(\alpha \text{ n-})(\phi \text{ lu})\text{-ni-}\eta$. The following tableau summarizes this, illustrated by $\text{ten-u-}\eta$ ‘I may hit it’.

(38) Foot construction from CVC-V-C ($\text{ten-u-}\eta$ ‘hit-3U-1sA’)

	TAUTO- ϕ	BIN- ϕ	FILL-C	PARSE- σ
$(\text{x})(\text{x} \cdot)$ $\text{te.n-u-}\eta$	*!*	*		
$(\text{x} \cdot)(\text{x} \cdot)$ $\text{ten-}\mu\text{u-}\eta$	*!		*	
 (x) $\text{te.n-u-}\eta$		*		*

The degenerate foot $(\phi \text{ te})$ is left unrepaired. The reason is the same as with the lexical monomoraic syllables like *mi* ‘fire’ in Section 4: if we assume the word minimality requirement to be part of universal grammar, it is always outranked in Belhare by FILL- μ ,

which proscribes mora epenthesis. There is no way of increasing the weight of (ϕ te) by, say, vowel lengthening. FILL- μ is also responsible for the fact that the CV-XVC input in (36) cannot be prosodically optimized by epenthesizing an additional mora to yield (ϕ CV μ)(ϕ -XVC), for instance, *(ϕ ta \mathfrak{a}).(yuk) from *ta-iuk* ‘come-NPT’ and *(ϕ ta \mathfrak{k}).(ket) from *ta-ket* ‘come-TEMP’.

Underparsing of syllables as in (38) is a general strategy to comply with TAUTO- ϕ . The effect of this is that many suffixal strings exhibit neither a detectable secondary stress pattern nor the pretonic vowel reductions characteristic of other polysyllabic words. An example from Section 3 is repeated here as (39a). The open syllable (ϕ bhu) is optionally reduced because it is followed by the heavy, foot-sustaining syllable (ϕ ruk). In a complex word like (39b), by contrast, the tautomorphemic foot constraint bans footing of *chi-k* so that (ϕ ru) is not in pretonic position. Hence it cannot be reduced:

- (39) a. ('wabhu)(ruk) \rightarrow ['wab^{fi}u₁ruk^ː] ~ ['wab₁r^{fi}uk^ː]
 ‘cucumber’
- b. ('tar-u)-chi-k-(khak)-cha \rightarrow ['taruchik₁khakcha], *not* *('taru)(chik)(khak)cha
 bring-3U-nsU-2-N-also \rightarrow *['tar₁chikkhakcha]
 ‘that you brought them as well’

Any sequence of at least two monosegmental affixes in a row irreparably violates TAUTO- ϕ . Notice that this is independent of where suffixes are located in the word, whether they are adjacent to the stem as in (38) or are found further down the suffixal string as in (39). Likewise, bimoraic suffixes show the foot optimization effects both when immediately following the stem as in (30) and when found between inflectional affixes. The latter case is illustrated by the following example involving the perfect marker *-hak* (~ *-khak* after stops). Morpheme-initial /h/ generally syllabifies with a preceding consonant, yielding a breathy voice onset (as in, e.g., *ten-he* ‘hit-PT’: [te.n^{fi}e]). This threatens the foot structure, and, as before, prothesis repairs the output:

- (40) $\begin{array}{l} \text{tai-}\eta\text{-i-}\eta\text{-hak-cha} \\ \text{come-INTR.PERF-1p-EXCL-PERF-also} \\ \text{‘We (pl., excl.) have come as well.’} \end{array} \quad \begin{array}{l} \text{(x.)} \quad \quad \quad (\text{ x.}) \quad \quad \quad \text{(x.)} \quad \quad \quad (\text{ x.}) \\ \rightarrow \text{'tai-}\eta\text{-i-}\eta\text{-}\eta^{\text{fi}}\text{ak-cha, not: *'tai-}\eta\text{-i-}\eta\text{-}\eta^{\text{fi}}\text{ak-cha} \end{array}$

However, one problem remains with the proposed account: in (39b) above, the first foot (ϕ tar-u) is in flagrant violation of TAUTO- ϕ . A similar case is found in (21b) from Section 4, repeated here and supplied with a morpheme analysis in (41). The telicity marker behaves

morphologically like a verb, from which it also derives historically via a compound verb construction (of a type common throughout South Asia). As a verb, *khar-* means ‘go’:


- (41) (rak)-(khar-e)-ŋa
 exhausted-TELIC-PT-EXCL
 ‘I got exhausted’

This is indeed possible, but only, as it were, under extreme circumstances. In Section 4, we observed that roots invariably receive initial (primary or secondary) stress. This suggests that there is a high-ranking constraint demanding that Belhare roots and root-like morphemes be part of a foot. This is captured in (42) by an ‘implication’ constraint, following Eisner (1996). An identity notation (McCarthy & Prince 1993a), say, $\sqrt{=}\phi$, is in conflict with the fact that feet are often bigger than the roots they contain; an Alignment-Theoretic notation (McCarthy & Prince 1993b), say, ALIGN-LEFT (ϕ , $\sqrt{}$) is problematic vis-à-vis roots with prothetic onsets as in (ϕ buk) ‘bring down’ in *lapbukma* ‘to catch and bring down’ from *lap-uk-ma* ‘catch-bring.down-INF’.

- (42) $\sqrt{\supset}\phi$: Lexical roots must be footed.

Given that $\sqrt{\supset}\phi \gg \text{TAUTO-}\phi$, avoiding heteromorphemic feet in (39b) and (41) would incur fatal violations of $\sqrt{\supset}\phi$ since the roots *tar-* and *khar-* would be left unfooted:

- (43) Foot construction from CVC-V (*~khar-e* ‘TELIC-PT’ or ‘go-PT’)

	$\sqrt{\supset}\phi$	TAUTO- ϕ	BIN- ϕ	FILL-C	PARSE- σ
(x .) ~kha.r-e		*!			
(x.)(x) ~khat.ɖe			*	*!	
 (x) ~kha.r-e			*		*
~kha.r-e	*!				**

Notice that among the remaining candidates, the one with foot underparsing (*khare*) beats the one with consonant prothesis (**khatɖe*). This shows that FILL-C dominates PARSE- σ , a ranking that was left unspecified in previous tableaux.

But this is not the full story yet. An alternative not mentioned in (43) would be to insert an onset so as to ensure that the first foot satisfies BIN- ϕ , but at the same to leave the second syllable unfooted: (ϕ khat)-ɖe. This output would indeed be prosodically more har-

monic than $(\phi \text{ kha})r\text{-e}$, which violates BIN- ϕ . Why is this alternative ruled out? Intuitively, it defies the very motivation of consonant prothesis, which is to mark the beginning of a new foot. The fact that this forces the preceding material (*khat*) to form its own foot is only a consequence, not the core purpose of prothesis. Moreover, all other cases of prothesis in Belhare are limited to footed (stressed) positions, that is, word-initially and at the beginning of bimoraic morphemes. As we saw in Section 3.2, there are no cases of prothesis that would simply serve the optimization of syllables: FILL-C-IN- σ dominates ONSET in Belhare, and indeed all other constraints, too. Against this background, it becomes clear why $(\phi \text{ kha})r\text{-e}$ is preferred to $(\phi \text{ khat})\text{-de}$. While FILL-C-IN- ϕ ranks lower than the foot structure constraints and therefore allows prothesis under stress, FILL-C-IN- σ is undominated and bans prothesis in unfooted positions:

(44) Foot construction from CVC-V (*~khar-e* ‘TELIC-PT’ or ‘go-PT’)

	FILL-C-IN- σ	$\sqrt{\supset}\phi$	TAUTO- ϕ	BIN- ϕ	FILL-C-IN- ϕ	PARSE- σ
$(x \quad .)$ ~.kha.r-e			*!			
$(x.) (x)$ ~.khat.-de				*	*!	
$(\quad x.)$ ~.khat.-de	*!					*
$\rightarrow (x \quad)$ ~.kha.r-e				*		*
~.kha.r-e		*!				**

This confirms the approach adopted in Section 3.2, which parametrizes FILL-C according to the Prosodic Hierarchy.

So far we have concentrated on TAUTO- ϕ violations when morphemes are suffixed to closed syllables. Open syllables with monosegmental affixes present an equal problem for TAUTO- ϕ : $(\phi \text{ CV-X})$ is an ill-formed foot. I first focus on CV-V sequences; CV-C is the case produced by augments, which is the topic of the next section. In the case of a CV-V input, the output is saved by underparsing in the same way as before. The stray syllable adjoins to the prosodic word-node (ω):

(45) $(\phi \text{ yu})\text{-a}$
descend-IMP
‘Go down!’

Independent evidence that underparsing and stray syllable adjunction is indeed what happens in cases like (45) comes from the following examples:

- (46) a. so-u-ha \rightarrow (ϕ so)yuha
 wait-3U-N
 ‘that s/he waits/waited for him’
 c. tu-u-ha \rightarrow (ϕ tu)yuha
 dig-3U-N
 ‘that s/he digs/dug it’

In a sequence of back (dorsal) vowels, stray-adjoined syllables are marked off by a prothetic glide (Bickel 1996a: 64). This never happens when the suffixes project heavy syllables and therefore sustain a foot of their own, cf. *u-uk-ma* ‘fry-bring.down-INF’ in (13) from Section 3.2, which is prosodified as (ϕ ?u)(ϕ uk)ma. From a purely metrical point of view, the two syllables (ϕ u)(ϕ ha) in (46) have the potential to sustain a foot. If they did project a foot, however, the environment where glide insertion takes place would be indistinguishable from the one where it does not; in both *u-uk-ma* ‘to fry and bring down’ and *tu-u-ha* ‘that s/he digs/dug it’ the two dorsal vowels would end up in exactly the same position, viz. between two feet: (ϕ ...u)(ϕ u...). Therefore, in order to explain where glide insertion takes place, we need to assume that (ϕ u) in (46) is footed in only of the two cases, and this is precisely the desired result.

5.2 Augment deletion

The constraint hierarchy established so far also allows a solution of the second puzzle mentioned in the introduction: the distribution of augments. In the preceding section we saw that the tautomorphemic foot constraint is systematically threatened by monosegmental affixes. The common strategy to repair the output is underparsing of feet. A similar strategy is applied to C-only suffixes, which are exemplified by the augments *-t* and *-s*. However, the effects of underparsing are more serious because it isolates the augment prosodically, making it prone to stray-erasure. Two cases need to be distinguished, potentially tautosyllabic augments — i.e., CV(C)-AUG-C or CV(C)-AUG)₀ — and potentially heterosyllabic augments — i.e., CV(C)-AUG-V. I first concentrate on potentially tautosyllabic augments.

Augments invariably follow lexical roots and this has the important effect that $\sqrt{\triangleright}\phi$ enforces footing of at least the first syllable. Since footing respects syllable boundaries (by

virtue of the Proper Bracketing Principle; cf. Section 3.2), underparsing the augment leaves it completely unprosodified. The syllable canon defined in (8) (i.e., ‘COND- σ ’) does not allow complex onsets and therefore prohibits adjunction of an augment to a following CV-syllable if there is any. Therefore, both before C and at a word boundary, augments are deleted, leaving only low-ranking PARSE-C(-IN- σ) violated (since prothesis is not at issue here, I leave out the FILL-constraints from the tableau to fit it on the page):

(47) Foot construction from CV-AUG-C... (*hi-t-ma* ‘be.able-AUG-INF’)

	COND- σ	$\sqrt{\supset}\phi$	TAUTO- ϕ	BIN- ϕ	PARSE- σ	PARSE-C
(x .) hi-t-.ma			*!			
(x) hi-.t-ma	*!			*		
☞ (x) hi-<t>-.ma				*		*
hi-t-.ma		*!				

An augment in word-final position is illustrated by (48), where *lu-t* ‘tell-AUG’ appears in an auxiliary constructions. Inflectional prefixes like *mai-* ‘me’ are extrametrical in stress structure and adjoin directly to the prosodic word node (see Bickel 1996a: 57):

- (48) *lu-t* *mai-met-t-he* \rightarrow ($_{\omega}(\phi$ ‘lu))($_{\omega}(\sigma$ mai)($_{\phi}$ ‘met)($_{\sigma}$ the))
 tell-AUG 1sU-CAUSE-AUG-PT
 ‘S/he caused me to tell him/her.’

This is general: in word-final position, C-only suffixes cannot appear after a footed CV-morpheme, and indeed there are virtually no such cases in Belhare.⁹ Note that things are different in unfooted syllables. Here, single C-affixes are unproblematic and can be regularly syllabified as codas as in, for example, ($_{\phi}$ te)($_{\sigma}$ n-u-ŋ) ‘I may hit it’ in (37a) or ($_{\alpha}$ n-)($_{\phi}$ lu)($_{\sigma}$ ni-ŋ) ‘I may not tell him/her’ in (37b). Underparsing of feet only entails stresslessness, not segmental deletion (‘stray-erasure’).

The deletion of preconsonantal and word-final augments is now explained as the result of COND- σ and TAUTO- ϕ dominating PARSE-C. Notice that COND- σ alone would not explain augment deletion, although in many cases augment deletion straightforwardly follows from COND- σ violations:

- (49) a. *rat-t-ma* \rightarrow *ratma* ‘to shout’, *not* **rat.t.ma*
 shout-AUG-INF

- b. leŋ-s-ma → leŋma ‘to turn’, not *leŋ.s.ma
turn-AUG-INF
- c. mu-s-ma → muma ‘to copulate’, not *mus.ma
copulate-AUG-INF

The crucial case is the type *hi-t-ma* ‘be.able-AUG-INF’ we looked at in (47) since a syllabification like $(_{\sigma} \text{hi-t})(_{\sigma} \text{-ma})$ would be perfectly well-formed. This is clearly evidenced by *hitma* ‘to watch’ which is in minimal opposition with *hima* ‘to be able’. The /t/ is part of the root in the former case, but an augment in the latter. In prevocalic position, it appears in both cases, if only with intersonorant rhotization following the pattern sketched in Section 2. The result is homophony:

- (50) a. hi-t-e → hire ‘s/he was able’
able-AUG-PT
- b. hit-e → hire ‘s/he watched’
watch-PT

The form in (50a) is well-formed for the same reasons as *khare* in (44) above: the second syllable is simply left unfooted, to the effect that it does not offend TAUTO- ϕ : $(_{\phi} \text{hi})(_{\sigma} \text{r-e})$. No segments need to be deleted.

This brings us to prevocalic augments in general. While, as we just saw, they are generally retained before single vowels, augment are deleted when preceding bimoraic suffixes. The reason lies again in the constraint hierarchy COND- σ , $\sqrt{\supset\phi} \gg$ TAUTO- $\phi \gg$ BIN- $\phi \gg$ PARSE- σ , PARSE-C contained in (47). While in (47), the ranking of PARSE-C vis-à-vis PARSE- σ was undetermined, however, the following shows that PARSE- σ dominates PARSE-C:

- (51) Foot construction from CV-AUG-VC (*lu-t-att* ‘tell-AUG-PT’)

	COND- σ	$\sqrt{\supset\phi}$	TAUTO- ϕ	BIN- ϕ	PARSE- σ	PARSE-C
(x)(x.) lu-.r-at			*!			
(x) lu-.r-at				*	*!	
(x) lu-.<t>at				*	*!	*
☞ (x) (x.) lu-.<t>at				*		*

The logic underlying (51) is this: its is better to create a well-formed foot than to preserve disturbing consonants. By contrast, if there is no way to create a perfect foot, consonant

deletion is not required. This is why underparsing the syllable is preferred to underparsing the augment in the CV-AUG-V structures exemplified by (50). The following tableau certifies this argument:

(52) Foot construction from CV-AUG-V (*hi-t-e* ‘be.able-AUG-PT’)

	COND- σ	$\sqrt{\supset}\phi$	TAUTO- ϕ	BIN- ϕ	PARSE- σ	PARSE-C
(x .) hi-.r-e			*!*			
(x)(x) hi-.r-e			*!	**		
ϕ (x) hi-.r-e				*	*	
(x) hi-.<t>e				*	*	*!
(x) (x) hi-.<t>e				**!		*

Another case of prevocalic augments is found when they follow closed syllable roots: CVC-AUG-V(C). In this case, augments are retained by a similar logic as in (52): deletion would not only not improve the ill-formed (ϕ AUG-V) foot, but would even worsen it, and (ϕ le η)(ϕ s-u) is more harmonic than degenerate *(ϕ le)(ϕ η -u) (cf. (3a) in the introduction):

(53) le η -s-u → (le η)-s-u! ‘turn it!’, *not*: *(le- η -u) or *(le) η -u
turn-AUG-3U

Before VC suffixes, by contrast, deletion is again the means of choice to optimize foot structure. The result is a CVC-VC pattern that is exactly the triggering environment for prothesis, just as in tableau (30).

(54) N-le η -s-att-u-n → n-(le η)(η at)t-u-n ‘s/he didn’t turn it’ (= (3b))
NEG-turn-AUG-PT-3U-NEG

An alternative option would be to follow the strategy of (52) and simply leave the TAUTO- ϕ -offending syllable (ϕ s-at) unfooted. The reason why this is less harmonic than augment deletion and consonant prothesis lies in the inherent weight of the suffix. Unlike the monomoraic suffix -u in (53), -att has the potential to yield a heavy syllable. As such, it attracts stress and therefore requires footing (cf., among many others, Prince 1983 or Halle & Vergnaud 1987). Under the FILL/PARSE approach to the Prosodic Hierarchy adopted in Section 3, this “Weight-to-Stress Principle” is equivalent to PARSE- σ_H (-IN- ϕ), where σ_H represents a heavy syllable. Since PARSE- σ_H stands to PARSE- σ in a relation of specific to

general, it follows from Pāṇini's Theorem (Prince & Smolensky 1993) that $\text{PARSE-}\sigma_H \gg \text{PARSE-}\sigma$. From tableau (38) in Section 5.1, i.e., from cases like $(\phi \text{ te})(\sigma \text{ n-u-}\eta)$ 'I may hit it', we know that not all heavy syllables are stressed. Hence, $\text{PARSE-}\sigma_H$ (or "WSP") must be dominated by other constraints. Its effects appear indeed only if there is a tie between $\text{TAUTO-}\phi$ and $\text{BIN-}\phi$, and this suggests that $\text{PARSE-}\sigma_H$ ranks lower than these two constraints. The following tableau shows that the argument is correct. To fit all relevant constraints onto the page, I consider only candidates that satisfy the higher-ranking constraints $\text{COND-}\sigma$ and $\sqrt{\supset}\phi$.

(55) Foot construction from CVC-AUG-VC (*leṇ-s-att* 'turn-AUG-PT')

	TAUTO- ϕ	BIN- ϕ	PARSE- σ_H	FILL-C-IN- ϕ	PARSE- σ	PARSE-C
(x.) (x.) leṇ-s-at-	*!					
(x)(x.) le. ṇ-<s>-at-	*!	*				*
(x)(x.) le. ṇ-<s>-at-	*!	*				*
☞ (x.) (x.) leṇ-<s>-ṇat-				*		*
(x.) leṇ-s-at-			*!		*	
(x) le. ṇ-<s>-at-		*!	*		*	*

The analysis contained in tableau (55) solves the last part of the puzzle described in the introduction, illustrated there by the examples in (3).

6. Alternative accounts and comparative issues

Is the complex machinery developed in the preceding necessary? At first blush, one might step back and assume that prothetic onsets are simply an historical relic of an erstwhile general onset requirement on all morphemes. Indeed, as we saw in Section 3.2, such a constraint is still operative in the language as far as word-initial morphemes are concerned. In this view, onsets would be inserted just in case they are followed by a suffix that still has an onset requirement. Thus, the minimal difference between morphemes like *-att* 'past' or *-hett* 'temporary' and morphemes like *-a* 'imperative' or *-u* '3U' would be that *-att*, etc., require a full-fledged onset while *-a* etc. do not. Evidence for such a distinction may be adduced from the fact it parallels to some extent a distinction between inflectional

morphemes and morphemes that are either lexical roots, or — speculatively! — grammaticalized verbs. Also, it is not implausible to assume that the *-hak* allomorph of the perfect marker illustrated by *tai-ŋ-i-ŋ-ŋhak-cha* ‘we (pl., excl.) have come, too’ in (40) above has an onset requirement in analogy to its post-stop variant *-khak* (as in *tai-ŋ-i-k-khak-cha* ‘come-INTR.PERF-2p-2-PERF-also’, i.e., ‘you (pl.) have come, too’), and this might explain why perfect forms show gemination. Such an analysis is more problematic in the nominal domain. The locative marker *-eC*, for instance, triggers prothesis, yet there is no evidence that the morpheme ever had an onset. The morpheme has an empty coda slot, which is filled with material from the right:

- (56) a. *khim-eC-khak* → *khimmekkh*a ‘the one in the house’
 house-LOC-N
 b. *khim-eC-tok* → *khimmetto* ‘right in the house’
 house-LOC-FOC

At any rate, whatever the real history of these markers is, an analysis on the basis of a lexically determined onset requirement is inadequate because it cannot explain why arguments are deleted in the same bimoraic environment that also triggers gemination, i.e., before VC-suffixes. If there were an onset requirement in such suffixes, one would expect the opposite since the augment would satisfy the onset requirement, for example, *n-lu-t-Catt-u-n* → **nlurattun* instead of the correct form *n-lu-att-u-n* ‘s/he didn’t tell him/her’. So we would need some constraint banning the lexical projection of an empty C-slot after arguments. Yet in whatever way such a constraint is formalized, it would be contradicted by the fact that arguments never block subsequent C-slots from appearance. On the contrary, it is the augment that is deleted before consonants:

- (57) *lu-t-pheĩ-t-u* → *lubheĩtu*, *not: *lureĩtu*
 tell-AUG-across-NPT-3U
 ‘S/he will tell him/her over there’

Here, the prosodic account proposed in the preceding sections is clearly more powerful. Moreover, all its ingredients are independently motivated and the analysis makes no questionable assumptions about empty syllable slots that would trigger alternations without ever surfacing themselves.

Another alternative analysis that one may entertain derives from Michailovsky’s (1986) work on similar effects in the Maivā-Mevā dialect of the closely related language Limbu. The core idea is that morpheme-final stops must be syllable-final. In Bickel (1996a, b) this

idea was independently developed for Belhare and captured by a syllabo-morphemic alignment constraint:

(58) ALIGN-RIGHT (σ , M)

The constraint is satisfied by inserting an onset consonant in V-initial suffixes. This seems to hold true for Limbu quite generally (unlike Belhare, prothetic consonants are always voiceless in this language):

(59) huk- ϵ n \rightarrow huk ᵑ ϵ n ‘the hand’
 hand-ART

According to Michailovsky’s (1986) analysis, the exceptions to this are not defined by the shape or nature of suffixes, but by the structure of stems they select. Apart from the regular ‘present’ stem, verbs have a “past” stem ending in a consonant that must be parsed as an onset:

(60) a. Present stem: CV(C)
 b. Past stem: CV(C).C

In most cases, the second onset consonant is represented by an augment (*phak* vs. *phak-t* ‘fold’), but the stem difference may sometimes rest entirely on lexical prespecification of the syllable break (*ha:p* vs. *ha:p* ‘cry, weep’). This gives rise to minimal pairs like the following:

(61) a. “Present Stem” CVC m ϵ n-ha:p- ϵ \rightarrow m ϵ nhap ᵑ ϵ ‘Don’t cry!’
 NEG-cry-IMP
 m ϵ n-phak- ϵ \rightarrow m ϵ nbhak ᵑ ϵ ‘Don’t fold it!’
 NEG-fold-IMP
 b. “Past Stem” CV.C ha:p- ϵ \rightarrow ha:b ϵ ! ‘Cry!’
 cry-IMP
 phak-t- ϵ \rightarrow phakte ‘Fold it!’
 fold-AUG-IMP

Applied to Belhare, this means that suffixes like *-a* ‘imperative’ or *-he* ‘past’ take the “Past Stem”, while the negative past marker *-att* or a VC-root take the “Present Stem”.

A crucial problem for this approach is that we find the same difference between geminating and non-geminating affixes at other than stem boundaries. While the relevant cases happen to lack from the available Maivā-Mevā dialect data, another dialect of Limbu, Phedāppe (van Driem 1987), shows that CVC inflectional morphemes do not always trigger gemination, i.e., that they behave sometimes like the “Past Stem” in (61b). This is the case with the reflexive marker *-siŋ* before *-i* ‘1st or 2nd person plural’ (62a), which contrasts with forms like (62b), where *-i:* ‘interrogative’ triggers gemination just as it does after closed stem syllables (62c).

- (62) a. *kε-ni-siŋ-i.* → *kεnisiŋi* ‘You saw each other.’ (van Driem 1987: 384)
 2-see-REFL-2p
 b. *kε-kho:s-u-m-i:?* → *kεgho:summi:* ‘Did you find it?’ (*op.cit.* 143)
 2-find-3U-2pA-Q
 c. *kε-sira-than-i:?* → *kεsiradhaŋi:* ‘Do you like it?’ (*op.cit.* 144)
 2-pleasure-come.up-Q

In Belhare, the situation is similar: the perfect marker *-hak* triggers gemination of inflectional affixes as in *tai-ŋ-i-ŋ-ŋ^fak-cha* ‘We (pl., excl.) have come too’ from (40) while, as the same form attests, the plural marker *-i* does not, just as its cognate in the Phedāppe Limbu form (62a).

These descriptive obstacles result from the fact that the analysis misses the generalization that it is exactly those suffixes that resist prothesis that consist of a vowel only, i.e., that are monomoraic. Such a transsyllabic restriction, however, makes sense only on the foot level, where moras are counted by TAUTO- ϕ and BIN- ϕ . Notice that the exceptional set is not semantically defined — certainly not by the notion “past”. Even in Maivā-Mevā Limbu, the label “Past Stem” (*thème du passé*) has no clear-cut semantic basis — including, as it does, the affirmative, but not the negative imperative. From a prosodic point of view, the problem is that in Maivā-Mevā Limbu (but not in Belhare) not all monomoraic morphemes belong to the exceptional set, i.e., there are V-only morphemes that do trigger gemination (61a). However, “les exemples sont rares, et diffèrent d’un dialect à l’autre” (Michailovsky 1986: 202). In fact, it seems that the only clear case is *-ε* in the negative imperative. Apart from this, there is the interrogative suffix *-i* and, restricted to the nominal domain, the vocative ending *-e*:

- (63) a. *ku-met-i* → *kumetti?* ‘His wife?’
 3POSS-wife-Q

- b. a-cum-e → ajumme! ‘Oh my friend!’
 1POSS-friend-VOC

There is evidence, however, that both these suffixes are underlyingly bimoraic, or were bimoraic historically: in contrast to Belhare, Limbu has distinctive vowel length, but closed /e/ is always long. The interrogative marker *-i* is long, too, in the Phedāppe dialect (cf. (62) above). The imperative marker may also have had a bimoraic origin since Phedāppe has *-ε?* instead of *-ε* (but note that it is uncertain whether a final glottal stop contributes weight).

Michailovsky (1986: 194) notes that in the dialects studied by him, length is neutralized in word-final position. Thus, it is not implausible to assume that underlyingly, all exceptional suffixes are bimoraic. If this is the case, gemination in Limbu would derive from the same prosodic structures as in Belhare. The historical scenario would be that some bimoraic suffixes lost weight in the surface but were lexically specified as ‘still counts as heavy’. It is natural to assume that the more frequent and less marked affirmative imperative should have gone a step further than its negative counterpart and completely lose all weight relevance.

Some additional plausibility for such a scenario comes from a parallel development in Belhare. In fast speech, there is a strong tendency to open word-final syllables, for example, *dabhe* instead of *dabhek* ‘sickle’. With many grammatical morphemes, this has become a regular alternation so that in word-final position *-yuk* ‘non-past’ appears as *-yu*, or *-kett* ‘inceptive’, after deletion of extrasyllabic *-t*, as *-ke*. Foot parsing and stress assignment is not affected by this reduction:

- (64) a. khat-kett-i → ('khat)(ket)ti ‘we (incl.) are off’
 go-INC-1p
 b. khat-kett → ('khat)(ke) ‘s/he is off’
 go-INC

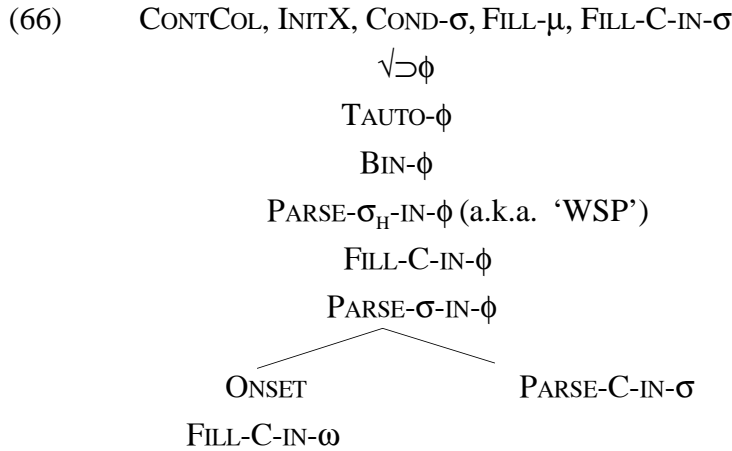
Indeed, word-final reduction does not affect prothesis either. As we saw in (40) and (56), respectively, the nominalizer *-hak* and the locative marker *-eC* trigger prothesis like any other bimoraic suffix. In word-final position, these suffixes are realized without the coda, yet the original coda still counts for prothesis as much as for stress assignment:

- (65) a. tai-ŋ-i-ŋ-hak → ('khai)ŋiŋ(ŋha), *not*: *('khai)(ŋiŋha)
 come-INTR.PERF-1p-EXCL-PERF
 b. khim-eC → ('khim)(me), *not*: *('khime)
 house-LOC

Whether a parallel analysis applies to exceptional suffixes in Limbu can only be answered by a thorough study of Limbu historical prosody. It is also possible that the exceptional suffixes are exceptional not because of underlying moraicity but for prosodic reasons of quite a different brand: it does not look accidental that they all mark special speech-acts (interrogative, vocative, imperative), whence there may be intonational top-down effects as well.

7. Conclusions

The puzzle introduced in the beginning of this paper is solved by the following hierarchy of constraints, which is arranged top-down:



While most of these constraints are already extensively motivated in the literature, the Belhare findings lend new support to Crowhurst's (1994) recently introduced TAUTO-MORPHEMIC FOOT ('TAUTO- ϕ ') constraint that proscribes feet crossing morpheme boundaries. This constraint triggers either prothesis of a consonant or underparsing of syllables. The choice is governed by the possible places of prothesis in the Prosodic Hierarchy. Unlike prespecified segments, prothetic consonants do not need to adjoin to a syllable node because they contain no features in need of prosodic licensing. This allows them to adjoin directly to the next higher level, the foot. FILL-C-IN- ϕ ranks lower than TAUTO- ϕ and therefore we get prothesis whenever there is enough material to build a new foot, that is, with bimoraic suffixes. FILL-C-IN- σ , which proscribes empty onsets in syllables, however, is undominated. Therefore, no prothesis is found when the material is sufficient only for a syllable, that is, with monomoraic suffixes. Instead of prothesis, underparsing is the strategy that is applied in this case. The final type of FILL-C constraints is FILL-C-IN- ω .

This constraint ranks lower than even ONSET in (66), which explains why Belhare requires glottal stop prothesis word-initially but not word-medially. Crucial for this analysis is the assumption that the Prosodic Hierarchy is not rigid but that its layering is the result of violable FILL and PARSE constraints in the spirit of Itô & Mester (1992) and Spaelti (1994).

Another important conclusion from the analysis offered in this paper is that the Belhare data strongly confirm the Principle of Metrical Coherence proposed by Dresher & Lahiri (1991): the moraic trochee template that underlies the Belhare stress system explains at the same time consonant prothesis and augment deletion — phenomena that would otherwise appear to be unrelated and difficult to account for. By the same token, these findings are strong support to the core idea of Prosodic Morphology, to wit, that morphological processes have access to prosodic information throughout a language.

Notes

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¹ ‘N’ is an underspecified nasality feature realized as a syllabic nasal or docked onto a preceding coda slot. The following abbreviations are used in morpheme glosses: A ‘actor’, ART ‘article’, AUG ‘augment’, BENEF ‘benefactive’, EXCL ‘exclusive’, FOC ‘focus’, INC ‘inceptive aspect’, INF ‘infinitive (citation form)’, IMP ‘imperative’, INTR ‘intransitive’, LOC ‘locative’, N ‘nominalizer’, NEG ‘negative’, NPT ‘non-past’, p ‘plural’, PERF ‘perfect’, POSS ‘possessive’, PT ‘past’, Q ‘question’, TEMP ‘temporary aspect’, U ‘undergoer’. I use lower-case Greek letters to symbolize prosodic (μ ‘mora’, σ ‘syllable’, φ ‘foot’, ω ‘word’) and capital Greek letters for morphological constituents (M ‘morpheme’, Σ ‘stem’, Λ ‘lexical word’, but √ for ‘root’). L and H represent light and heavy syllables, respectively. In metrical grids, head moras are represented by ‘x’, other moras by dots (following Hayes 1995: 39).

² For typographical convenience, I represent breathiness by a superscript ^h. In the practical Roman and *devanāgarī* orthographies, voicing is written irrespective of its distinctiveness. The voice correlation of aspirates is exceptionally distinctive in [takhumbit] ‘shawl’ and [somphorok] ‘lung’.

³ An explicit account for this observation, which is fully in line with coronal peculiarities in many other languages around the globe, must be left to another essay. The coronal stop is also special phonetically in that it has a secondary glottal constriction before /l/, e.g., /ɳatlabu/: [ɳat^hlabu] ‘banana’. A further special aspect of /t/ is that it dissimilates to a glottal stop before a coronal glide, e.g., *khat-iuk* ‘go-NPT’ → *khat-yuk* → [khaʔ^hyu] ‘s/he goes’ (on glide formation, see the discussion of example (32) in Section 5.1).

⁴ Here is the complete list from a dictionary with about 1000 entries (Bickel 1997): *co’congī* ‘star’, *i’tiikha* ‘(very) small’, *khi’riʔwa* ‘cricket’, *u’choūat* ‘new’, *u’siʔwa(t)* ‘dry firewood’, *wa’reŋ* ‘in the future’, *wa’remba* ‘tomorrow’, *ya’haʔwa* ‘rice paddy’. It is possible that CVʔ derives historically from a bimoraic syllable, although nowadays the glottal stop does not contribute weight anymore (see below). The odd σ_Lσ_L pattern on *i’titi* ‘as small as’ is in minimal opposition with *i’titi* ‘very small’. This is the only case where stress is contrastive in Belhare. These words involving the notion of ‘small’, including *i’tiikha*, seem to be borrowings from Nepali *eti* (< *yati*) ‘this much’ or Maithili *etak* ‘id.’, which are typically used for small amounts. The native root for ‘small’ is *cii-*, which is also used frequently.

⁵ FOOTFORM always requires moraic trochees. This is not repeated in the tableaux.

⁶ See Itô (1990) for the general idea of prosodically driven segment insertion.

⁷ I concentrate here and in the following on the negative past morpheme *-att* because, unlike suffixed VC-roots, it is semantically compatible with all (verb) roots. Since the second /t/ is always syllabified with subsequent morphemes I leave it out in prosodified representations as much as the syllabic nasal which is prefixed to the prosodic word (cf. (8)) and thus ignored by foot and stress structure.

⁸ The generalized version is fully compatible with Crowhurst’s (1994) data. Crucial test cases like CV-C or CVC-V are lacking, though.

⁹ There is one exception, *ca-m* ‘let’s eat it’, but this form is completely irregular in other respects, too. It derives from *ca-u-m* ‘eat-3U-1pA’ with an otherwise unattested pattern of vowel coalescence (see Bickel 1996: 63)

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